Environmental Science
Environment, Ecosystems and Biodiversity
Lecture 10

Types of Diversity

Now if you look at the different types of diversities, species diversity is very crucial. It actually defines as variety of different species of living forms in a given area. India has around 2 crore species of the total species described. The species diversity peaks in the tropical forest and coral reefs.

Then you have the Genetic diversity. This is defined as "the variation at the level of individual genes' or 'the heritable variation within and between populations of organisms'. The more genetic diversity in a population, the more the chances in variations. These variations actually help the individuals to have a variant that help it to be suite for a new environment. More variations are available, it is possible for that organism or that creature to thrive better in different conditions because they can get different variety from different gene pools. Ecosystem is the structural and functional unit of the biosphere. Ecosystem diversity is defined as 'the aggregation of various habitats, community types and abiotic environment in a given area.' India has one of the richest ecosystem diversity, ranging from deserts, plains, hills, mangroves, rainforests to the very cold Himalayas. If you look at the distribution of biodiversity here, you have floura and fauna diversity, it depends on climate, altitude i.e the elevation from sea level, soils, presence of other species so that the species could interact with them. Most of the biodiversity is concentrated in the Tropical region. You have biodiversity hotspots, a region with high biodiversity with most of the species being Endemic. India has two major biodiversity hotspots; East Himalayan Region and Western Ghat.

Hotspots of Biodiversity

Now if you look into the hotspots of biodiversity. Hotspots are the main areas of focus for biodiversity conservation. These are the areas that are extremely rich in biodiversity, have high level of endemism, and are under constant threat of species extinctions and habitat destruction. Areas which exhibit high species richness as well as high species endemism are termed as hotspots of biodiversity. These hotspots covering less than 2% of the world's land area are found to have about 50% of the terrestrial biodiversity. These are the hotspots you see. You can see there is a concentration on the tropical belt since the climate is more favourable. The kind of flora and fauna there is more favourable. You have China, North-eastern parts of Asia that has got a good belt then the very parts of Africa, again you have South America and Central America that enclose the next region of hotspots. If you look at the list of hotspots that are across the world. This is important because, most of the biodiversity that's recorded in the world are actually from these hotspots. It's not actually possible to study

every nook and corner of the world. With advancement in technology, it is pretty much considered that no part of the Earth is considered unexplored. But for practical purposes, when you are discussing about different types of species of plants and animals where the study has to be done much more closely, there are a lot of areas that are unexplored and unidentified species are still there. Everyday new species are being discovered. Some of the hotspots we have here are; Tropical Andes, Mesoamerica, Caribbean, Brazil's Atlantic Forest, Choco/Darien/Western Ecuador, Brazil's Cerrado, Central Chile, California Floristic Province, Madagascar, Eastern Arc and coastal forests of Tanzania/Kenya, Western African Forests, Cape Floristic Province, Succulent Karoo and on the eastern side, you have the Mediterranean Basin, Caucasus, Sundaland, Wallacea, Philippines, Indo-Burma, South Central China, Western Ghats, Sri Lanka, SW Australia, New Caledonia, New Zealand, Polynesia or Micronesia. You can see that we actually occupy one of the hotspots of the world. Like we discussed, its mostly the tropical areas. This term 'hotspots' was introduced by Norman Myers in 1988. Myers had later wrote about it and recognized 25 such hotspots in the world. These are on a global level, out of which two are present in India, namely the Eastern Himalayas and Western Ghats. According to Myers in 2000 revelation, an area is considered to be a hotspot when it constitutes at least 0.5% of the plant species as endemics. The Indian hotspots are not only rich in floral wealth and endemic species of plants but also reptiles, amphibians, swallowtail butterfly and some mammals as well. Nearly 70% of the bird species in this hotspot are endemic. These are areas of high diversity, endemism and are also threatened by human activities. About 40% of terrestrial plants and 25% of vertebrate species are endemic and found in these hotspots. The 25 hotspots contain 44% of all vascular plant species, 35% of terrestrial vertebrates and encompass only 1.4% of the Earth's surface. You can see what a small percentage of area we are actually talking about. All of this calculation becomes very important when we are talking about threats to biodiversity and conservation of biodiversity. However, collectively they have lost 88% of their original primary vegetation. Species in these areas are at risk from extinction if further habitat loss occurs. It has been estimated that about 50,000 endemic plants which comprise 20% of global plant life probably occur only 18 hotspots in the world. Countries that have a relatively large proportion of this biodiversity hotspots are referred to as mega diversity nations, like we saw; China, Central America and parts of South America. Moving on to the hotspots in our country, we have Eastern Himalayas and the Western Ghats, these areas are particularly rich in floral wealth and endemism, not only in flowering plants but also in reptiles, amphibians, swallow tailed butterflies, and some mammals.

If you look at the Eastern Himalayas, we are talking about the border between China as well as India and you have the area that comprises Nepal, Bhutan and neighbouring states of Northern India along with continuous sector of the Yunnan province in Southwest China. All Himalayan forests lie north of the tropic of Cancer and some of them are at altitudes of 1780 - 3500 m,

they can be considered tropical forests. Many deep and semi isolated valleys are exceptionally rich in endemic plant species. In Sikkim, in an area of 7298 km2, of the 4250 plant species, 2550 (60%) are endemic. In Nepal, there are around 7000 plant species, many of which overlap with those of India, Bhutan, and even Yunnan. Of these nearly, 500 are believed to be endemic to Nepal. Bhutan possesses an estimated 5000 species, of which as many as 750 are considered to be endemic to the Eastern Himalayas.

Now, moving on to the Western Ghats, if you look at the map, this is the area we are discussing about and even parts of Sri Lanka as well, because the type of weather conditions that is prevalent here, is there. We will discuss about the Western Ghats. Out of nearly 49219 species, 1600 endemic i.e 40% are found in 17000 km, along the sea side of the Western Ghats in Maharashtra, Karnataka, Tamil Nadu, Kerala. Forest tracks up to 500 in elevation, comprising one-fifth of the entire forest expanse are mostly evergreen with those in 500-1500 m range and these are considered semi-evergreen. Then you have two main centres of diversity, the Agasthyamalai Hills and the Silent Valley which is the reserve basin. The forest cover in the Western Ghats has reduced 34% from 1972 - 1989. The floral and fauna commonality of India's two hotspots. Although the two areas (the Eastern Himalayas and the Western Ghats) are today disjunct and have their own characteristic flora and fauna, there are a number of species common to both. Common floral species include Ternstroemia, Japonica, Rhododendron arboreum, Hypericum hookerianum, Thalictrum Javanicum, Cotoneaster buxifolia, Parnassia wightiana, Lonicera ligustrina, Gaultheria fragrantissima, and Symplocos laurina. Amongst all these kind of faunas prevalent, you have the Himalayas and Nilgiri Tahr, the Nilgiri Pine Marten, the Laughingthrush associated with the plant genus Rubus, the Great Pied Hornbill, the Frogmouth, the Fairy Bluebird, the Lizard Hawks and the Rufous Bellied Hawk-Eagle, these are all found in both the regions. So, inspite of them being so vastly spaced and so diverse in terms of climate and other geographical factors, there are a lot of common species that these two share.

There are 10 biogeographical regions in India. You have the Trans-Himalayan - the orange belt you see here is the Himalayan, you have the Indian desert right here on top, then you have the Semi-arid zone just below the desert and then the thriving Western Ghats which we discussed as the hotspot now. Then the largest Deccan Peninsula, then you have the Gangetic plane, a very thriving fertile piece of land. North Eastern India again, is very good for its bio diversity. Islands of Andaman and Nicobar and finally, the coast along the East. Even though it is not as diverse as the Western Ghats because of the lack of mountain region, the coast also offers a very good combination of bio diversity.

Endemic species - these are species that are found only in a particular geographical region because of its isolation, soil and climatic conditions. These species are considered very

important because, if these species are removed from there and kept in another area. I am not talking about zoos and places like that but if they shifted to another area, they cannot thrive under similar conditions, they will not be able to reproduce, they will not be able to sustain anywhere else but their original habitat. That is why endemic species are so important and in any ecosystem and wherever you are studying flora and fauna, endemic species are identified at once to realize how important is that particular region. The number of Endemic species are neglent or not even there at all, that area cannot be considered a biodiverse area or a hotspot because that area can be reproduced or reciprocated elsewhere.

Certain Endemic species of our country - we have discussed the Nilgiri tower, we have certain fruit trees and all of these are considered vulnerable as well as threatened. Again over here, when you are looking at biodiversity, you have different scales. We have decided what are the endemic species of our country but the next stage that needs to happen is, what is vulnerable, what is threatened or vulnerable or rather which part of it is endangered or close to extinction. All these variety of words being used, make a huge difference of what exactly is the step that is required in the conservation of biodiversity.

When you think of vulnerable or threatened species, these are the species whose population number is declining and are likely to become endangered with time if no intervention takes place i.e if no positive steps are taken to conserve them. The list of threatened animals have been listed in a book called 'Red Data Book' or RDB. RDB was first formulated by Sir Peter Scott. The major threatened categories under IUCN are Extinct, Endangered, Vulnerable, Rare and Interminate species. When you think or Interminate species, there are the kind that will be there only in certain areas but are not viable in other areas. Rare and Interminate are pretty much the same, then vulnerable which could be natural or manmade, that is getting threatened or their numbers are drastically dropping. The list of few mammals which occur in India and are labelled as threatened under the 2003 IUCN (International Union of Conservation of Nature and Natural Resources) red list are displayed in the next slide. You have the Asiatic golden cat, Asiatic lion, Indian wild khur, Asiatic wild ass, Nilgiri leaf monkey, you have so many, you have about 18 to 15 identified species in mammals and then you have some animals and plants which are not getting adequate attention and one of the main reasons this is said to be tourism. This becomes a vicious circle of disgust even before, when more time and effort is invested in research, as people enter these forests because of which the species get a lot of negative exposure in the sense, a lot of poachers are made aware of hotspots, biodiverse areas and if adequate security isn't given to these hotspots or the animals, the research done proves to be detrimental. You have the Nilgiri Tahr which is a kind of deer, the Himalayan Tahr, Wild goat, Gaur, Asiatic black bear and the Asiatic Elephant and obviously, you can see the reasons why

these animals were hunted. Right from the tusk, the skin, to the horns; all these are prime products received from these animals and they are poached and hunted carelessly.

Moving on to Endangered species, these are the species whose numbers are critically low and their habitat is so drastically reduced that they are in danger of extinction. At present you have 81 species of mammal, 38 species of birds, 18 species of amphibians and reptiles which are considered endangered species in India. Now, you have the critically endangered mammals, which is the Jenkin's Shrew, the flying squirrel, the fruit bat, the free-tailed bat, the Malabar large spotted civet, the Pygmy hog and then you have the Sumatran rhinoceros. All of these seven are considered critically endangered mammals and you have the international authority warning each government that see - as your endangered list is piling up, the funds being sent over will reduce. They want to give certain incentives to help us protect our environment. Like we just saw, all of this study, research, if there is no adequate support to help these hotspots and biodiverse regions, these endangered species will soon becoming extinct. This is the pygmy hog, the large spotted civet and the Sumatran Rhinoceros.

Benefits of Biodiversity

Now what are the benefits of Biodiversity? We have seen the importance of it but you have three main benefits because for man to save anything, he needs to have an idea of what prosperity he is getting, what are the positive impacts he'd gain, only then will any kind of funding related to it, will be considered an investment. Biodiversity is actually known for multiple benefits. It goes beyond the simple thing of quantifying the importance of biodiversity. It is because of biodiversity that man exists. If biodiversity is lost, even man will soon become extinct. We have Economic benefits, Ecological benefits and Ethical benefits. Economic benefits encompass food, all our food comes from plants and animals. About 80,000 plant species are potential food sources. Agriculture - the genetic diversity of wild plants are used to produce better strains of crops with superior yields. Then you have Medicine, medicinal plants for ayurveda, yunani medicine or even great pharmaceutical industries produce synthetic drugs whose origin is plants. Industries - the wood from plants is being used in industries for clothing, shelter, fuel, raw material, paper, rayon, plastic, construction, etc. The modern green revolution, the farmers begin to lose their traditional systems of sustainable agriculture. However, the Beej Bachao Andolan, the BBA has helped revive the traditional farming methods. Lesser known plants and animals of food value. There are more than 10,000 varieties of cereals but human have concentrated only on four namely; rice, wheat, corn and Jowar. Examples are there on the next slide.

You have medicinal plants; aloe vera, different kinds of grains and other kinds of plants that are used in cosmetics, that are actually used in different kinds of medicines, to treat certain kinds of diseases like Hodgkin's disease, treatment of Leukemia and types of cancer. Then you have

alkaloids produced from these plants that help treat Schizophrenia, heart problems and High B.P. Like I just mentioned, the more research we do on these plants, the more we are actually getting them into a detrimental situation because we realize that there is more use to them and as man is greedy as he is, he wants to keep taking and the level of replenishment that happens is very less or minimal.

Ecological or Social benefits, Biodiversity is important for maintenance and sustainable utilization of goods and services from ecological systems. The services include formation and protection of soil, conservation and purification of water, maintenance of hydrological cycle, etc. Forest vegetation provides natural protection to soil as soil binders that prevent soil erosion and also slow down water flow to downstream areas. The pores and cracks found in between soil particles act as natural filters purifying water as it drips through the forest ecosystem. This not only helps in protection and conservation fertile topsoil, but also maintains ground water.

Plants absorb water from soil or water reservoirs and added to the air as water vapour by the process of transpiration. Animal and plants also lose water in vapour form during respiration. Water vapour formed by transpiration and respiration formed clouds and enter global water cycle or Hydrological cycle. Next you have, Soil microbes or decomposers and soil animals like earthworms help in efficient breakdown of organic matter into inorganic nutrients, thus enriching the soil fertility.

Ethical - Cultural, Spiritual and Religious belief systems - Throughout human history people have also related the very existence of human race to biodiversity. Let it be through cultural, spiritual or even religious beliefs. Many plants, animals, forests, landscapes and rivers and considered as sacred and worshipped by people. Today there have become cultural heritage and these beliefs have played an effective role in conservation of many species of plants and animals, especially in the preservation of many endemic and rare species. If you look at sacred species, traditional plant and animal species of religious and cultural importance; Tulasi, Neem, Ashoka tree, the Pipal tree and animals like cow, monkey, cobra etc. All of these have a level of religious spiritual context which helps people save these particularly.

Sacred grooves - it's a small patch of land with natural flora and fauna protected by local community in dedication of their deities or ancestral spirits. These grooves can range from few trees to large forest areas like Devar Kadu and Boothasthanas. These thanas are basically where flowers and fruits are grown for giving to their idle for religious purposes. All of these are storehouses of many rare and endemic species. Then you have the sacred landscapes, its a large heterogeneous area that contains a variety of natural and traditionally managed ecosystem. For example - the river Ganga is considered a holy river, the stretch of Ganga

between Haridwar and Rishikesh is considered Machhiyal where fishing is actually band. In Karnataka, important sacred landscapes include Kudachadri hills in Western Ghats of Kollur, BR Hills and the temple and Bababudangiri Hills.

This is the Kudachadri hills, this is the area of Macchiyal when no fishing is permitted, you can see the fish thriving in the water. This is the Bababudangiri hills, again the waterfalls, the greenery, nothing is tampered with. When a religious connotation is attached to it, people are scared to do anything to damage it.

Biodiversity and the Balance of Nature

We saw tropic levels, elimination of species from tropic levels can cause destruction of the ecosystem, as well as the biodiversity. **Complex ecosystem** - in a complicated ecosystem, having several tropic levels, loss of one or more species does not cause any serious problems because alternatives are definitely available. Certain **Keystone species -** loss or addition of species cause detectable changes in ecosystem rates i.e species make unique contribution to ecosystem functioning. **Niche Complementary -** Difference among species in their requirements for different resources will cause complimentary interaction, so that a species could obtain more resources.

Facilitation and Mutualism - plants may also benefit from their neighbours through amelioration of the physical and biotic environment. Portfolio effect, this is where the species richness increases the temporal stability of the entire community while the biomass is stabilized. Insurance Hypothesis this is where Biodiversity buffers ecosystem against environmental changes such as global warming.

Benefits of Biodiversity - The Consumptive value like we have seen; food, drink, fuel, medicine, batter crop varieties, Industrial varieties. Non-consumptive value yo u have; Recreation, Education and research, traditional value.

Ecological services - they actually help balance nature, biological productivity, Regulation of climate, Degradation of waste, Cleaning of air and water, Cycling of nutrients, Control of potential pest and disease causing species, Detoxification of soil and sediments, Carbon sequestration and global climate change, Maintenance of soil fertility, Pollution, Hunting, Global warming and climate change, agriculture and Domino effect.